1984

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This study analyzed the physical fitness performance of 141 youngsters with spinal neuromuscular conditions, by age, sex, and severity of condition, and compared the performance of these subjects with 1,192 normal youngsters on selected physical fitness test items. Boys and girls, ages 10-17, with paraplegic spinal neuromuscular conditions were tested on 11 physical fitness test items which were modified, as necessary, for their participation. Where comparisons were appropriate, the scores of normal subjects of the same sex and age generally exceeded significantly those of the paraplegic subjects. There was a trend for paraplegic subjects to possess larger skinfolds than normal youngsters, and, where differences existed in skinfolds, the skinfolds of older paraplegic subjects exceeded those of younger paraplegic subjects. Few significant sex and age differences emerged for the paraplegic group on nonskinfold (performance) items. The test battery administered did not discriminate among the performance of subjects with various levels of spinal lesions at or below the sixth thoracic vertebra.

Although some research has been conducted relative to physical training techniques and their effectiveness relative to certain types of individuals with orthopedic impairments (Berg, 1970; Berg, 1971; Berg & Bjure, 1970; Brown, 1975; Healy, 1957; Meditch, 1961; Robson, 1972; and Royer, 1979), little information is available in regard to the quantitative physical fitness abilities of youngsters with orthopedic impairments. Also, there is little mention of tests to measure the physical fitness abilities of persons with such impairments. The fact that little research has been conducted on the topic is not entirely by accident or neglect. The diverse etiology of orthopedic impairments; the limitations placed on youngsters by themselves and others; the wide variation in their functional levels and abilities; the complexity involved in conducting such research; concern about the value of quantitative data; and orientation regarding treatment and development have all contributed to the lack of research. These reasons are obstacles which must be overcome not only for

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This study was conducted as part of Project UNIQUE which was designed to investigate the physical fitness of normal (nonimpaired) youngsters and youngsters with sensory and orthopedic impairments. Project UNIQUE was funded by Special Education Programs, U.S. Department of Education, Grant No. G007902258, Project No. 023CH10058. The opinions presented herein are those of the authors and do not necessarily reflect the position or policy of Special Education Programs and no official endorsement by Special Education Programs should be inferred.

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conducting research but for designing, implementing, and evaluating programs designed to meet the unique individual needs of this group of youngsters.

This study was conducted to provide a better understanding of the physical fitness of youngsters with paraplegic spinal neuromuscular (PSN) conditions. Specifically, it was designed to study the influence of sex, age, and severity of condition on the physical fitness performance of PSN youngsters and, where appropriate, to compare performance with normal youngsters of the same sex and age.

Procedures

Subjects

To attain the objectives of the study, 11 measures of physical fitness were administered to 141 individuals with PSN conditions and 7 measures of physical fitness were administered to 1,192 normal subjects. All subjects were ages 10-17. The subjects for this study were selected from two major categories: normal (Boys: Ages 10-13 [n = 292], Ages 14-17 [n = 219]; Girls: Ages 10-13 [n = 379], Ages 14-17 [n = 302]) and paraplegic spinal neuromuscular conditions (Boys: Ages 10-13 [n = 39], Ages 14-17 [n = 33]; Girls: Ages 10-13 [n = 45], Ages 14-17 [n = 24]). Spinal neuromuscular conditions were defined as acquired or congenital conditions characterized by spinal lesion which directly affected limb functioning. However, subjects with progressive muscular conditions associated with spinal lesions were not included in the study. Thus, the study included individuals with postpolio, spina bifida, and traumatic spinal cord injury. In accord with the National Wheelchair Athletic Association sport classification system, spinal neuromuscular conditions were more specifically subclassified according to the site of spinal cord lesion as follows: (a) all cervical lesions, (b) lesions from T1 (first thoracic vertebra) to T5, (c) lesions from T6 to T10, (d) lesions from T11 to L2 (second lumbar vertebra), and (e) lesions at or below L3. However, only paraplegic subjects with lesions occurring at or below T1 were included in the present project because of insufficient subject numbers in the first subclassification.

All subjects were free of multiple handicapping conditions. Subjects with impairments were selected from both institutionalized (n = 51) and noninstitutionalized (n = 90) settings as earlier defined by Winnick and Short (1982). A normal or nonimpaired subject was one who was not identified as handicapped by the school district, free from impairments or disabilities which may have influenced test results, and who attended regular classes in noninstitutionalized regular schools. The sample of normal subjects was randomly selected, to the extent possible, from those schools which agreed to participate in the study. In most cases, intact physical education classes were randomly selected from the physical education schedule. The sample of normal subjects has been described in more detail by Winnick and Short (1982). The number of subjects completing each test item is presented in Table 1.

Collection of Data

Data were collected throughout the United States in several schools, agencies, or institutions by competency-trained testers. In collecting data from various parts of the United States, it was necessary to develop a testing network consisting of a central

Table 1

Number of Subjects According to Age and Test Items Performed[a]

	Normal				Paraplegic Spinal Neuromuscular			
	Younger		Older		Younger		Older	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Triceps skinfold (mm)	259	332	192	284	38	45	32	24
Abdominal skinfold (mm)	257	330	192	284	34	43	28	23
Subscapular skinfold (mm)	258	330	192	284	35	44	30	24
Right grip (kg)	221	331	197	292	39	43	29	24
Left grip (kg)	220	330	197	292	39	43	30	24
Arm hang (sec.)	264	359	194	292	32	36	24	21
Pull-ups (no.)	284	358	188	284	31	34	24	22
Shuttle run (sec.)	--	--	--	--	38	42	29	22
50-yard dash (sec.)	--	--	--	--	36	40	26	23
Softball distance (inches)	--	--	--	--	37	44	31	23
Long distance run (yards/minute)	--	--	--	--	25	29	24	25

[a]Except in the long distance run, younger includes ages 10-13 and older includes ages 14-17. In the long distance run, younger includes ages 10-12 and older includes ages 13-17.

staff, regional coordinators, and field testers. The central staff selected and trained regional coordinators and field testers, who, in turn, selected and trained other field testers relative to the protocols of the study. All coordinators and field testers were required to successfully complete a training program designed to provide skills and knowledge necessary for data collection. Testers were also provided with a manual containing detailed procedures for test administration and data recording. In addition to providing training, coordinators located testers in their region, recommended participating school districts and subjects for the study, coordinated testing schedules, and dispensed equipment, as necessary. Field testers, consisting mostly of teachers of the subjects tested, identified subjects, attained permission to test subjects, administered tests, recorded data, and transferred data to the project's central staff. The central staff at Brockport checked data according to specific procedures, prepared data for computer analysis, and analyzed, synthesized, and interpreted the data.

Measurement of Physical Fitness

For the purposes of the study, physical fitness was defined as consisting of four specific abilities or components which, although related, are discrete enough to warrant separate measurement. Physical fitness was also conceived as involving both health-related and physical performance-related components necessary for developing optimal health and enhancing performance in daily activities, occupational activities, and sport performance. In accord with the AAHPERD Health Related

Physical Fitness Test (AAHPERD, 1980) which was designed to measure health-related physical fitness and the AAHPER Youth Fitness Test (AAHPER, 1976) which includes measures of physical performance-related fitness, this study assumed that the basic components underlying health and performance-related physical fitness include muscular strength/endurance, cardiorespiratory endurance, body composition, and flexibility. Several items from these tests were selected for the present study, however, a measure of flexibility was not included because the sit and reach test (the measure of flexibility adopted for use in Project UNIQUE) was inappropriate for the PSN subjects. Test items associated with the other three components were: (a) body composition: triceps skinfold, subscapular skinfold, and abdominal skinfold, (b) muscular strength/endurance: right grip, left grip, arm hang, pull-ups, shuttle run, 50-yard dash, softball throw for distance, (c) cardiorespiratory endurance: long distance run (ages 10-12: 1 mile or 9-minute run; ages 13-17: 1.5 mile or 12-minute run).

Since the primary objective of this study was to investigate the physical fitness performance of subjects with PSN conditions, the performance of these subjects on all 11 test items was analyzed and will be presented. Comparison of their performance with normal subjects was completed in cases in which both groups followed similar procedures (7 items). The scores of normal subjects on the shuttle run, 50-yard (45-m) dash, softball throw for distance, and long distance run were not compared with the PSN group, and thus, no further discussion of the performance of normal subjects on these items will be presented.

The long distance run, triceps skinfold, and subscapular skinfold, were administered with few exceptions, according to procedures outlined in the Health Related Physical Fitness Test (AAHPERD, 1980). However, in this study, PSN youngsters were required to perform the long distance run in a standard (as opposed to a racing) hand-driven wheelchair. Youngsters, ages 10-12, were instructed to wheel 9 minutes or 1 mile and youngsters, ages 13-17, were instructed to wheel 12 minutes or 1.5 miles (2.4 km). If they completed the distance before the corresponding time was reached, they were instructed to stop. If they failed to complete the distance in 9 or 12 minutes, as appropriate, they were instructed to stop. From this information, yards/minute was used as the criterion score. In this study, all skinfolds were measured using Lange skinfold calipers and the criterion score was the mean of three trials recorded correct to the nearest millimeter.

The pull-ups, flexed arm hang, shuttle run, and the 50-yard dash were administered in accordance with procedures outlined in the AAHPER Youth Fitness Test (AAHPER, 1976). However, because subjects with PSN conditions were specifically included in the present study and because a preference for the pull-ups or flexed arm hang had not been determined in previous research with this population, both items were administered to boys and girls. The mean of two trials was recorded as the criterion score in the flexed arm hang test and one trial was provided in the pull-up test. For PSN subjects, bars were lowered so that wheelchair participants could pull themselves out of their wheelchairs; otherwise, subjects were lifted to the bar when possible. In the shuttle run, the mean of two trials rather than the better score in two trials served as the criterion score. PSN subjects performed the shuttle run in standard wheelchairs designed for daily use. Subjects wheeled to two wooden blocks which were set up on an inverted wastebasket (ranging in height from 15 to 25 inches [38 to 63 cm]). Subjects picked up one block, placed it on their lap, and wheeled

back to the starting line. The block was then dropped to the floor behind the starting line. The subjects returned to the second block, picked it up off the basket, placed it on their lap, and wheeled as quickly as possible past the start/finish line. The PSN subjects performed the 50-yard (45-m) dash in their wheelchairs. (For all three running items, one PSN subject moved the wheelchair forward with his feet, all other PSN subjects propelled the wheelchair with their arms.)

The abdominal skinfold was a vertical fold taken at a site two inches to the right of the person's midline in line with the umbilicus, and parallel to the long axis of the body. The mean of three trials, recorded to the nearest millimeter, served as the criterion score. In the grip strength tests, both normal and PSN subjects squeezed a Smedley-type adjustable hand grip dynamometer to the maximum extent possible while seated. Three trials, alternating right and left hands, were administered to each subject. All scores were recorded to the nearest kilogram and the criterion score was the mean score of three trials for each hand. In the softball throw for distance test item, the PSN subjects were instructed to throw a regulation softball overhand, at an angle of approximately 40°, as far as possible from a seated position. Subjects were instructed to lock the brakes of their wheelchair prior to throwing. The average of three throws (following warm-up and two practice throws), correct to the nearest inch, served as the criterion score. Distance was measured from a throwing line to the point at which the ball landed on the fly.

Results

Data were analyzed using both multivariate and univariate analysis of variance techniques. Multivariate analyses were performed utilizing the data from subjects who took all the items in the test battery. In cases where the multivariate analysis was significant, post hoc univariate analyses were calculated using the data from all subjects who took the particular item. This was felt to be an appropriate analysis of the data since many PSN subjects were not able to take all the items in the battery for various reasons primarily related to accessibility (e.g., unavailability of appropriate running surfaces, pull-up bars at inconvenient heights). In fact, less than half of the PSN sample took all the items in the battery. It was felt that by including all the available data in the univariate analyses the sample would become more representative of the population and, thus, enhance the generalizability of the results. Significant interactions obtained for the univariate analyses of variance were analyzed graphically (means were plotted with 99% confidence intervals). The $p < .05$ level of significance was adopted for all multivariate analyses and the $p < .01$ level for all univariate analyses.

Comparison of Normal and PSN Subjects

The mean values for normal and PSN subjects on the physical fitness items are presented by sex and age group in Table 2. A three-way ANOVA design was used to investigate sex, age, and condition factors among normal and PSN subjects on those items where procedures were reasonably similar (skinfolds, grip strength, arm hang, and pull-ups). Due to the relatively low number of PSN subjects in the study, the age variable was reduced to two groups for data analysis: 10 to 13 years of age and 14 to

Table 2

Mean and Standard Deviation Values for Normal and Paraplegic Spinal Neuromuscular Subjects by Age on Test Items[a]

	Normal				Paraplegic Spinal Neuromuscular			
	Younger		Older		Younger		Older	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Triceps skinfold (mm)	13.0 (5.4)	13.0 (6.7)	11.7 (4.7)	14.7 (7.1)	16.4 (6.5)	13.4 (6.7)	13.7 (8.1)	20.8 (7.8)
Abdominal skinfold (mm)	11.5 (11.5)	13.7 (8.3)	12.4 (12.4)	15.1 (8.5)	16.6 (7.0)	14.3 (8.0)	18.0 (10.9)	22.2 (16.7)
Subscapular skinfold (mm)	9.4 (5.2)	10.6 (5.7)	10.9 (4.4)	11.7 (5.7)	14.1 (6.4)	11.1 (6.4)	14.8 (9.3)	18.4 (10.9)
Right grip (kg)	20.4 (7.1)	18.4 (6.9)	41.8 (10.1)	26.3 (6.7)	18.3 (13.0)	11.3 (6.7)	30.7 (13.6)	20.3 (8.9)
Left grip (kg)	17.7 (6.7)	16.3 (6.9)	37.9 (9.8)	22.6 (6.3)	16.1 (12.9)	10.3 (6.2)	27.5 (14.4)	18.5 (9.0)

Arm hang (sec.)	20.2 (22.9)	9.5 (11.7)	19.2 (11.6)	7.8 (9.0)	5.3 (8.4)	3.8 (5.6)	7.9 (7.0)	2.5 (4.2)
Pull-ups (no.)	2.9 (2.9)	0.9 (1.9)	6.0 (3.9)	0.6 (1.6)	1.3 (2.1)	1.2 (2.1)	3.3 (3.4)	0.4 (1.0)
Shuttle run (sec.)	--	--	--	--	30.8 (10.7)	32.1 (12.2)	41.9 (46.9)	31.5 (7.7)
50-yard dash (sec.)	--	--	--	--	25.6 (11.2)	28.4 (12.4)	39.2 (68.1)	25.0 (9.9)
Softball distance (inches)	--	--	--	--	391.9 (257.9)	213.1 (120.6)	439.1 (228.1)	224.1 (84.0)
Long distance run (yards/minute)	--	--	--	--	87.9 (32.7)	84.9 (30.9)	78.0 (40.9)	75.4 (29.1)

[a]Except in the long distance run, younger includes ages 10-13 and older includes ages 14-17. In the long distance run, younger includes ages 10-12 and older includes ages 13-17. Standard deviations are presented within the parenthesis.

17 years of age. Since educational environment was found not to be a significant factor on physical fitness test performance, the PSN group included pooled data from both institutionalized and noninstitutionalized subgroups.

The results of the multivariate ANOVA indicated that all three, two-way interactions were significant in this analysis [$n = 990$; Sex × Age: $F(7,976) = 47.49$; Condition × Sex: $F(7,976) = 4.79$; Condition × Age: $F(7,976) = 2.62$]. Since the multivariate ANOVA indicated the presence of an "interaction model," a univariate analysis was performed. The results of the three-way univariate ANOVA are presented in Table 3 and are discussed below for each item.

Triceps Skinfold. A significant sex by age by condition effect emerged on the triceps skinfold (Figures 1A and 1B). Sex was a significant factor for older (14-17) normal subjects; girls had larger skinfolds than boys. Sex was not a significant factor for younger (10-13) normal subjects or for PSN subjects in either age group. Age was not significant for normal subjects or for PSN boys, but older PSN girls had significantly larger skinfolds than younger PSN girls. Older PSN girls had significantly larger skinfolds than older normal girls, but no other condition effects were significant.

Abdominal Skinfolds. Only the main effects of age and condition were significant on the abdominal skinfolds. Older subjects had significantly larger skinfolds than younger subjects and the subjects with PSN conditions had significantly larger skinfolds than normal subjects.

Subscapular Skinfolds. A significant sex by age by condition effect was obtained for the subscapular skinfold measure (Figures 1C and 1D). Neither age nor sex was a significant factor for either group of subjects. Younger PSN boys had significantly larger skinfolds than younger normal boys and older PSN girls had significantly larger skinfolds than older normal girls.

Right Grip Strength. The three-way sex by age by condition interaction was significant for the right hand grip strength (Figures 1E and 1F). Sex was a significant

Table 3

Univariate F Values for Normal and Paraplegic Spinal Neuromuscular Subjects by Sex, Age, and Condition

Test Item	Sex	Age	Cond.	Sex × Age	Sex × Cond.	Age × Cond.	Sex × Age × Cond.
Triceps skinfold	8.69*	4.57	25.82*	31.19*	.22	3.38	8.91*
Abdominal skinfold	5.13	14.12*	35.72*	5.23	.99	5.17	2.81
Subscapular skinfold	1.52	23.89*	54.00*	8.69*	.41	6.28	10.71*
Right grip	132.92*	284.01*	75.69*	31.62*	.00	6.93*	11.26*
Left grip	116.05*	248.74*	56.75*	33.78*	.35	5.51	13.62*
Arm hang	25.95*	.05	43.17*	.63	7.15*	.51	.31
Pull-ups	104.22*	14.47*	17.38*	37.63*	19.43*	2.20	.30

*$p < .01$

factor for older normal subjects (boys had higher scores than girls), but no other sex differences were observed (differences between PSN boys and girls were significant at the $p < .05$ level, but not at the $p < .01$ level). Regardless of sex or condition, older subjects made significantly higher scores than younger subjects on the right hand grip strength. Normal girls had significantly higher scores than PSN girls in both age groups. Older normal boys significantly surpassed the performance of older PSN boys; however, there was no significant difference between younger normal and PSN boys.

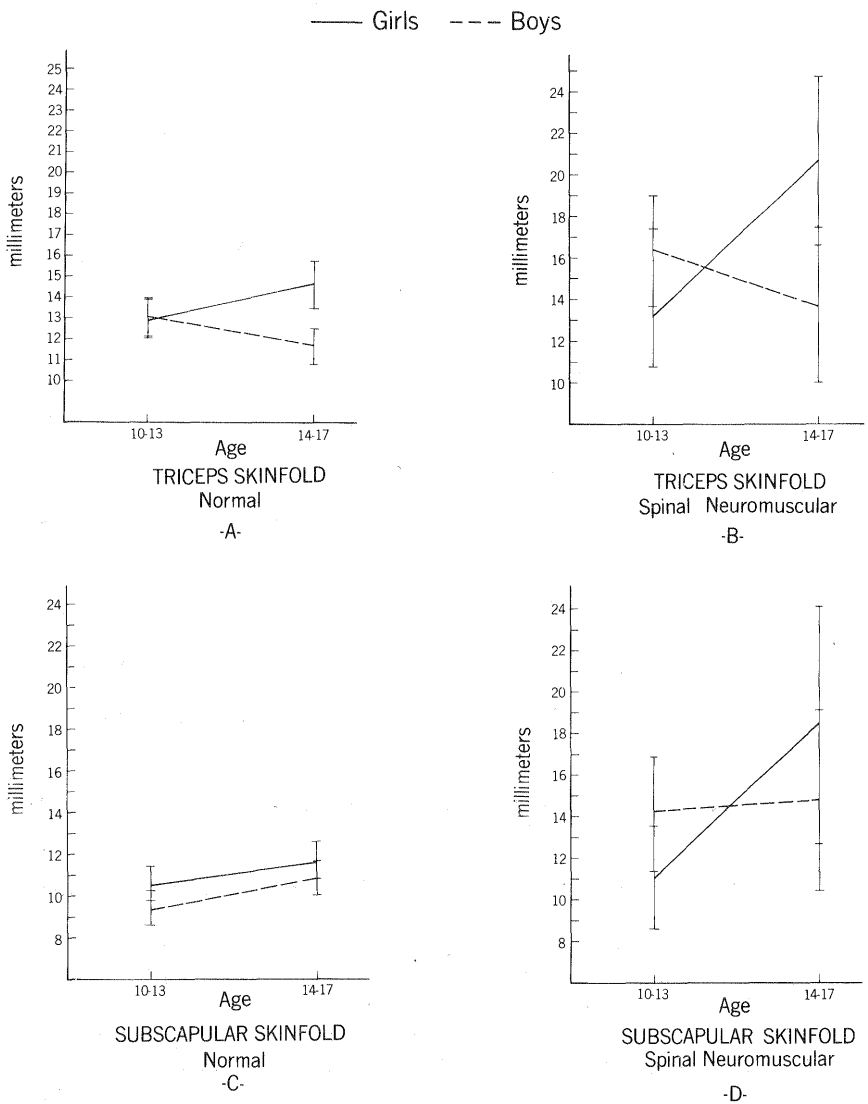

Figure 1 — Significant sex by age interactions for each condition (means plotted with 99% confidence intervals).

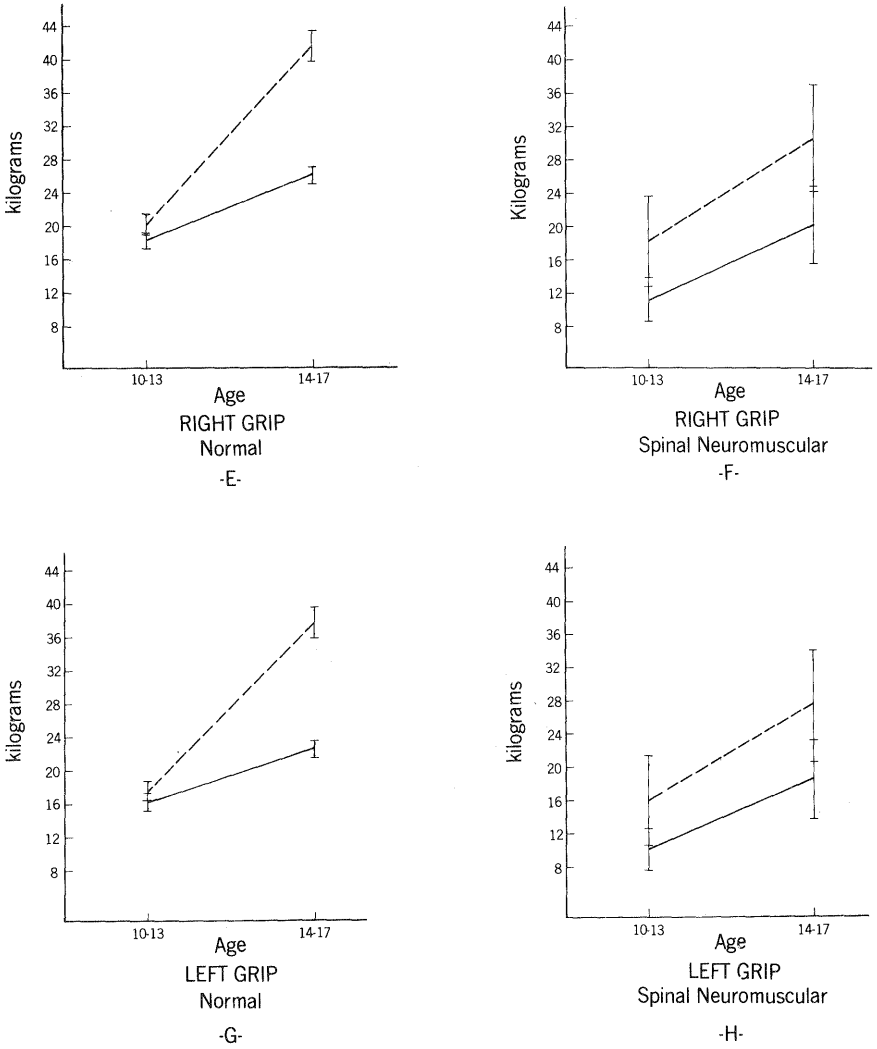

Figure 1 (cont.) — Significant sex by age interactions for each condition (means plotted with 99% confidence intervals).

Left Grip Strength. As with the right grip strength, the analysis of the left hand grip strength yielded a significant three-way interaction (Figure 1G and 1H). Similarly, sex was a significant factor for older normal subjects (boys did better), but no other sex differences were observed. Age was a significant variable for normal subjects and PSN girls (older subjects surpassed the performance of younger subjects), but no such difference was found for PSN boys. Older normal boys achieved significantly higher scores than older PSN boys, but the difference between younger normal and PSN boys was not significant. Conversely, younger normal girls achieved significantly higher scores than younger PSN girls, but the difference between older normal and PSN girls was not significant.

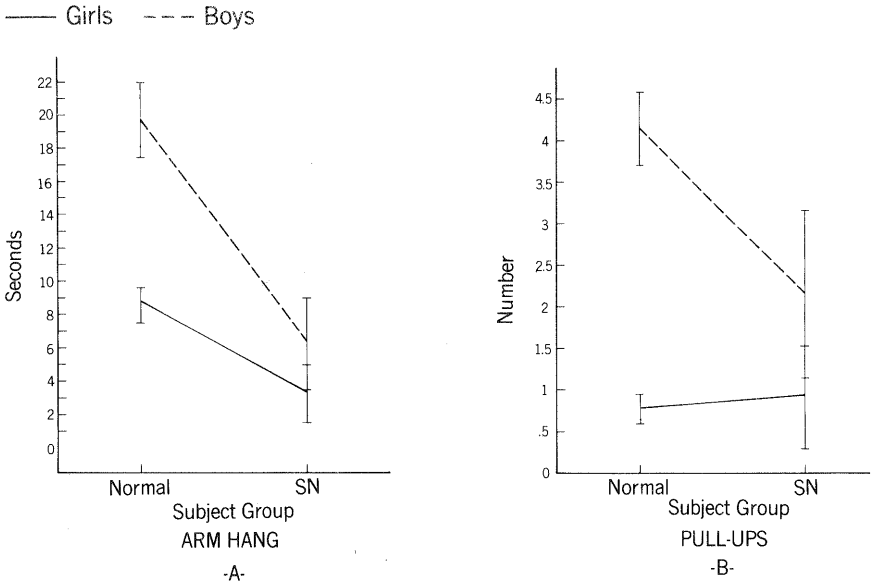

Figure 2 — Significant sex by condition interactions (means plotted with 99% confidence intervals) for normal and paraplegic spinal neuromuscular subjects.

Flexed Arm Hang. Sex was found to be a significant factor for normal subjects (boys exceeded the performance of girls), but no significant sex difference was found for PSN subjects on the flexed arm hang (Figure 2A). Regardless of sex or condition, age was not a significant variable on this item. Normal subjects performed significantly longer flexed arm hangs than PSN subjects (Figure 2A).

Pull-ups. Sex was a significant factor for normal subjects on the pull-ups (Figure 2B). Normal boys performed more pull-ups than normal girls. This difference was operative for both younger and older subjects (Figure 3). No significant sex difference was observed for PSN subjects. Boys, regardless of condition, im-

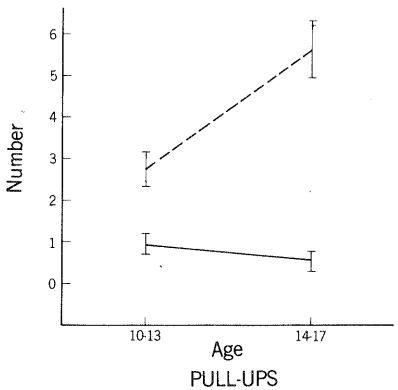

Figure 3 — Significant sex by age interaction (means plotted with 99% confidence intervals) for normal and paraplegic spinal neuromuscular subjects.

proved significantly with age, but the age difference was nonsignificant for girls. Normal boys performed a significantly greater number of pull-ups than PSN boys, but the difference between normal girls and PSN girls was not significant (Figure 2B).

Sex and Age Comparisons Within the PSN Group

Univariate F values for PSN sex and age comparisons are presented in Table 4 for four test items (shuttle run, 50-yard dash, softball distance, and long distance run). Comparisons on these items were not made with normal subjects since procedures were vastly modified for some PSN subjects. The multivariate analysis of these data yielded a significant main effect for sex [$n = 98$; $F(4,91) = 7.64$]. The data in Table 4 indicate that sex was a significant factor (favoring boys) for PSN subjects on the softball throw. No other significant sex or age differences were found on these four items.

Table 4

Univariate *F* Values for Paraplegic Spinal Neuromuscular Subjects by Sex and Age

Test Item	Sex	Age	Sex × Age
Shuttle run	1.13	1.47	1.84
50-yard dash	.91	.73	2.03
Softball distance	28.58*	.62	.24
Long distance run	.09	1.26	.02

*$p < .01$

Severity of Handicapping Condition

Since it is logical to hypothesize that performance scores of youngsters are effected by severity of condition, the effect of severity of condition on the performance of PSN subjects whose level of spinal cord involvement was known was examined. Severity of condition was defined by the site of spinal cord lesion and included lesions between T6 and T10 inclusive ($n = 19$), lesions between T11 and L2 inclusive ($n = 29$), and lesions at L3 or below ($n = 17$). (An insufficient number of subjects in the T1-T5 group obviated the inclusion of this group in the analysis.)

A one-way multivariate analysis was performed. The dependent variables were the 11 test items deemed appropriate for PSN subjects, and the independent variable was the site of spinal cord lesion. The MANOVA indicated that the site of lesion was not a significant factor on performance [$n = 65$; $F(22,104) = .82$]. The test items, therefore, did not discriminate among PSN subjects with lesions occurring at T6 or below.

Summary and Discussion

With the exception of skinfold measures, the scores of normal subjects were generally significantly superior to those of PSN subjects on the seven test items on which they were compared. No significant differences, however, were found between younger (10-13) normal and PSN boys on the grip strength measures, or between older (14-17) normal and PSN girls on left hand grip strength. In addition, no significant differences were found between normal and PSN subjects (both age groups) on pull-ups. It is possible that PSN subjects compared relatively well with normal subjects on these items because of the involvement of their hands and arms in wheelchair propulsion. Although not all comparisons were significant, there was a trend for PSN subjects to have larger skinfold measures than normal subjects. The findings of this study, therefore, are in agreement with others which have found that individuals with handicapping conditions are below normal subjects on indices of physical fitness (Buell, 1966; Rarick & Dobbins, 1972; Rarick & McQuillan, 1977; Winnick & Short, 1982). Winnick and Short (1982) noted that the performance differences between normal subjects and PSN subjects were greater than the performance differences between normal subjects and subjects with either visual or auditory impairments.

Although there was a tendency for the mean scores of PSN boys to be superior to those of PSN girls, only one significant sex difference (boys exceeded girls on the softball throw) emerged on performance items within the PSN group. Since the scores of boys have been generally found to exceed those of girls on measures of physical fitness (flexibility items excluded), this finding is not in agreement with other studies. The lack of a significant difference between boys and girls in this study may be due to a relatively inactive lifestyle of both sex groups resulting in low fitness. The fact that PSN boys significantly exceeded PSN girls on the softball throw may be due to sex-role stereotyping of the activity.

Few significant age differences emerged for the PSN group. Age was significant for PSN subjects on right hand grip strength (older subjects scored higher), for PSN girls on left hand grip strength (older subjects scored higher), and for PSN boys on pull-ups (older boys scored higher). Relative to skinfold measures, older PSN girls significantly exceeded younger PSN girls on triceps and abdominal skinfold measures. Older PSN boys significantly exceeded the abdominal skinfold of younger boys. Where significant differences occurred, therefore, they were in directions expected. It is expected that youngsters will increase grip strength with age due to increased muscle mass. Also, increases in skinfold are expected in view of gains in weight. However, readers must be cautioned that increases in skinfold do not necessarily result in increases in percent of body fat. The fact that significant age differences did not occur to a great extent within the PSN group may be a finding of most importance. Normal boys tend to improve their physical performance throughout the developmental years, whereas normal girls tend to improve in measures of physical fitness until the ages of 12 to 14, at which time their performance frequently stabilizes and sometimes declines (Winnick, 1979). The relative lack of significant improvement in physical fitness measures by PSN subjects with age, may be due to a more sedentary lifestyle as age increases.

The results of this study indicate that site of lesion occurring at T6 or below did not discriminate performance on the test items. Evidently, the test items ad-

ministered could be equivalently accommodated by paraplegic subjects since they were characterized by upper body involvement.

The relative inferiority of PSN subjects on physical fitness measures and their lack of improvement with age supports the contention that more attention and emphasis must be given to the physical fitness development of individuals with PSN conditions. In essence, more physical activity must be included in their general lifestyle. Physical educators and other professionals who have responsibility for enhancing physical fitness must recognize and accept this responsibility and provide opportunity for physical fitness development. Since PSN subjects generally fall below normal levels and often display wide variation in performance, it may be necessary to begin programs at very basic levels. Furthermore, the wide variations exhibited necessitate individualized programming. Finally, professionals responsible for implementing programs must be motivated and properly educated (including preparation for working with youngsters with PSN conditions) to provide quality individualized programs.

References

American Alliance for Health, Physical Education, and Recreation (1976). *Youth fitness test manual* (Rev. ed.), Washington, DC: American Alliance for Health, Physical Education, and Recreation.

American Alliance for Health, Physical Education, Recreation, and Dance (1980). *Lifetime health related physical fitness test manual*, Reston, VA: American Alliance for Health, Physical Education, Recreation, and Dance.

Berg, K. (1970). Effect of physical training on school children with cerebral palsy. *Acta Paediatrica Scandinavica* (Suppl. 204), 27-33.

Berg, K. (1971). Remarks on physical training of children with cerebral palsy. *Acta Paediatrica Scandinavica* (Suppl. 217), 106-107.

Berg, K., & Bjure, J. (1970). Methods for evaluation of the physical working capacity of school children with cerebral palsy. *Acta Paediatrica Scandinavica* (Suppl. 204), 15-26.

Brown, A. (1975). Review: Physical fitness and cerebral palsy. *Child: Care, health and development*, **1**, 143-152.

Buell, C.E. (1966). *Physical education for blind children*. Springfield, IL: Charles C. Thomas.

Dobbins, D.A. & Rarick, G.L. (1975). Structural similarity of the motor domain of normal and educable retarded boys. *Research Quarterly*, **46**, 447-456.

Healy, A. (1957). *A comparison of two methods of weight training for children with spastic type of cerebral palsy*, Unpublished master's thesis, State University of Iowa.

Meditch, C. (1961). *Effectiveness of two methods of weight training for children with athetoid type of cerebral palsy*, Unpublished master's thesis, State University of Iowa.

Rarick, G.L., & Dobbins, D.A. (1972). *Basic components in the motor performance of educable mentally retarded children: Implications for curriculum development*. Final Report, Project No. 142714, Department of Health, Education and Welfare, U.S. Office of Education, Bureau of Education for the Handicapped. Berkeley, CA: Department of Physical Education, University of California.

Rarick, G.L., & McQuillan, J.P. (1977). *The factor structure of motor abilities of trainable mentally retarded children: Implications for curriculum development*. Final Report, Project No. H23-2544, Department of Health, Education, and Welfare, U.S. Office of Education, Bureau of Education for the Handicapped. Berkeley, CA: Department of Physical Education, University of California.

Robson, P. (1972). Cerebral palsy and physical fitness. *Developmental medicine and child neurology*, **14**, 811-813.

Royer, D. (1979). The applications of aerobic and anaerobic training to wheelchair athletes. In Steadward, R.D. (Ed.) *Proceedings of the first international conference on sport and training of the physically disabled athlete* (pp. 80-95). Department of Physical Education, Edmonton, Canada: University of Alberta.

Winnick, J.P. (1979). *Early movement experiences and development: Habilitation and remediation*. Philadelphia: W.B. Saunders.

Winnick, J.P., & Short, F.X. (1982). *The physical fitness of sensory and orthopedically impaired youth*. Project UNIQUE Final Report. Physical Education Department, Brockport, NY: State University of New York, College at Brockport.